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RESEARCH ARTICLE

Effect of alternate nostril breathing on acute stress-induced changes in cardiovascular parameters in obese young adults

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ABSTRACT

Background: Obesity is a major problem in young adults. They are more prone to develop hypertension. Cold pressor test (CPT) is an autonomic function test which produces acute stress. Alternate nostril breathing (ANB) exercise may be helpful in reducing the elevated sympathetic activity in obese and may be helpful in coping up the stress in obese subjects. **Aims and Objectives:** The aim of the present study was to find out the effect of ANB on acute stress-induced changes in cardiovascular parameters in obese young adults. **Materials and Methods:** A total of 60 obese male subjects (body mass index > 30) participated in the present study. CPT was performed to induce acute stress. Cardiovascular parameters were recorded using impedance cardiovasograph and mercury sphygmomanometer before CPT and in recovery phase in Step 1 and were repeated in Step 2 with ANB exercise. Statistical analysis was done by one-way ANOVA and Tukey *post-hoc* tests. **Results:** The study results showed that all the cardiovascular parameters were significantly higher ($P < 0.05$) immediately after CPT in Steps 1 and 2 and in recovery phase of Step 1. However, all cardiovascular parameters returned to baseline in recovery phase of Step 2 with ANB. **Conclusion:** Results indicate that ANB exercise modulates the cardiovascular changes produced by acute stress in obese subjects leading to faster recovery and reduces the sympathetic activity with increase in parasympathetic activity.

KEY WORDS: Alternate Nostril Breathing; Cold Pressor Test; Impedance Cardiovasograph; Obese

INTRODUCTION

Obesity is a state of excess deposition of adipose tissue in the body. It is a major problem in young adults of high socioeconomic status. The major cause of obesity is excess intake of calories with relatively less expenditure. Body mass index (BMI) is a valuable tool for determination of obesity. BMI of 30 is commonly used as threshold for obesity. Obesity is one of the risk factors for the development of hypertension, diabetes, and other cardiovascular disorders.[1,2]

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Many researchers have reported relatively high sympathetic activity in obese population. Therefore, obese people are more susceptible to stress-induced adverse changes in the body.[3,4]

Stress is the subjective state of sensing potentially adverse changes in the environment. Response to stress varies from person to person and more pronounced in obese. Behavioral adaptation occurs in response to stress in normal person, but failure of adaptation leads to the development of disease.[5,6] Stress of any type stimulates sympathetic nervous system. Experimental stress can be induced by cold water in cold pressor test (CPT) which has been widely used as test for autonomic functions. It involves immersion of the hand in cold water of 8°C producing acute stress and leading to intense stimulation of sympathetic nervous system and almost complete withdrawal of parasympathetic activity.[7] Cardiovascular parameters are very sensitive to any change in autonomic status and can be precisely recorded using impedance cardiovasograph (nivomon). It measures the stroke volume (SV), heart rate (HR), and blood flow index (BFI) of the person non-invasively.[8]

Yoga and meditation has been practiced from ancient time in India. Various studies have shown that yogic exercises may reduce the ill effects of stress on the body and improve health.[9,10] Yogic exercises have been found to relax the body and relive the stress. Beneficial effects produced by yoga seem to be related to shifting of sympathovagal balance toward vagal side with less activity of sympathetic nervous system.[11,12] Alternate nostril breathing (ANB, Anulom-Vilom) is a very popular yogic exercise. It involves voluntary alternation in nostril breathing in a controlled manner. Several investigations have suggested that ANB shifts the sympathovagal balance toward parasympathetic side as it enhances the parasympathetic activity and reduces the sympathetic activity. ANB has also been found to improve the cardio respiratory functions.[13,14] As ANB may modulate the autonomic nervous system, the present study was conducted to find out the effect of ANB on acute stress-induced changes in cardiovascular parameters in obese young adults.

MATERIALS AND METHODS

The present study was conducted in the Department of Physiology, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India. A total of 60 asymptomatic healthy obese male subjects (BMI ≥ 30), aged 17-25 years, participated voluntarily in the present study undertaken, to assess the effect of ANB on acute stress-induced changes in cardiovascular parameters in obese young adults.

Inclusion Criteria

Healthy male subjects having BMI > 30 as per the World Health Organization (WHO) criteria for obesity were included in this study.

Exclusion Criteria

subjects with BMI < 30 (non-obese), with history of smoking or alcoholism and acute or chronic disease, were excluded from the study.

Females were also excluded because of changes in autonomic and hormonal status during various phases of menstrual cycle (greater parasympathetic tone during early to mid-follicular phase, higher HR in the mid- and late-luteal phase).[15,16]

Experiment procedures were in accordance with the Ethics Committee on human experimentation. The present study was carried out at ambient temperature with minimal external or internal sound disturbances in the room. Subjects reported to laboratory 3 h after light breakfast. They were explained in detail about the experimental procedure. Informed consent was taken from all subjects. Baseline characteristics of all obese subjects were recorded (Table 1). Body surface area (BSA) (m^2) and BMI (kg/m^2) were calculated by standard formula using weight (kg) and height (cm) of the subjects. Blood pressure was recorded using mercury sphygmomanometer. Impedance cardiovasograph recorded SV, HR, and BFI. Systolic blood pressure (SBP), diastolic blood pressure (DBP), and BSA data feeding was carried out manually in impedance cardiovasograph. Using all these data, computer software of impedance cardiovasograph computed other cardiovascular parameters and displayed all of them.

The procedure was conducted in two steps. In the first step, subjects were asked to sit comfortably with backrest. Cardiovascular parameters were recorded after 10 min of rest. The study subjects dipped their left hand in water of 8°C for 2 min. Above-mentioned parameters were recorded again immediately and at 5 min after removal of hand from cold water. In next step, subjects took rest of 10 min again in sitting position. All the above steps were repeated with a modification that subjects performed ANB exercise during CPT and continued performing it for next 5 min. All the parameters were recorded before CPT, immediately after CPT and 5 min after CPT.

Formulas used for calculations were as follows:

1. BMI (kg/m^2) = Weight (kg)/height (m^2)
2. BSA (m^2) = SQRT [{Height (cm) × Weight (kg)}/3600]
3. COP (L/min) = SV (L/beat) × HR (/min)
4. CI ($L/min/m^2$) = COP (L/min)/BSA (m^2)
5. SVI ($ml/beat/m^2$) = SV (ml/beat)/BSA (m^2)
6. SVR (dyne. s/cm^5) = 80 × (MAP−CVP)/CO
7. SVRI (dyne. $s/cm^5/m^2$) = SVR (dyne. s/cm^5)/BSA (m^2)

Statistical Analysis

Statistical analysis was done by one-way ANOVA and Tukey *post-hoc* tests using the (window) SPSS Statistics 17.0 version. Data were expressed as mean and standard deviation and $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 shows the baseline characteristics of the subjects as mean (SD) age 22.3 (2.4) years, height 170.6 (4.3) cm, and weight 91.6 (4.7) kg. Calculated BSA and BMI were 21.1 (0.04) m^2 and 31.3 (1.2) kg/m^2, respectively.

Table 2 shows comparison of parameters before and after CPT. There was significant increase in all cardiovascular parameters immediately after exposure to cold stress for 2 min. Increase in HR, SPR, SVRI, and DBP was highly significant ($P < 0.01$) while increase in SV, SVI, CO, CI, and SBP was less significant ($P < 0.05$). However, all the cardiovascular parameters did not return to normal after 5 min. All the cardiovascular parameters were significantly higher 5 min after CPT in comparison of basal parameters ($P < 0.05$).

Table 3 shows the comparison of parameters before and after CPT with subjects performing ANB during CPT and in recovery phase after CPT. All cardiovascular parameters increased significantly immediately after CPT even the case was performing ANB. Increase in HR, SPR, SVRI, and DBP was highly significant ($P < 0.01$) while increase in SV, SVI, CO, CI, and SBP was less significant ($P < 0.05$). However, all the cardiovascular parameters returned to normal after 5 min and there was no significant difference in parameters before CPT and 5 min after CPT with ANB ($P > 0.05$).

Table 1: Baseline characteristics of all obese subjects

Baseline characteristics	n=60
Age (in years)	22.3 (2.4)
Height (cm)	170.6 (4.3)
Weight (kg)	91.6 (4.7)
BSA (m^2)	2.1 (0.04)
BMI (kg/m^2)	31.3 (1.2)

BMI: Body mass index, BSA: Body surface area

DISCUSSION

The present study shows significant increase in all cardiovascular parameters immediately after CPT in both Steps 1 and 2 which indicates marked sympathetic stimulation in obese by cold stress. In Step 1, delayed recovery from the effects of stress was observed in obese subjects that might be associated with relatively higher sympathetic activity in obese. Excess weight gain, baroreflex dysfunction, reduced Nitric oxide formation, increased levels of angiotensin II, and leptin have been reported as underlying cause for increased sympathetic nervous system activity in obese.[3,4] Results from the present study also reveal that ANB helps in faster recovery from the stress as seen in Step 2. This indicates that after removal

Table 2: Comparison of cardiovascular parameters before and after CPT in obese

Cardiovascular parameters	Before CPT	Immediately after CPT	5 min after CPT
Systolic blood pressure (mm Hg)	117.8 (6.6)	138.3 (6.3)*	123.5 (5.4)#
Diastolic blood pressure (mm Hg)	75.4 (4.2)	89.3 (5.4)**	80.1 (4.8)#
Heart rate (per minute)	72.8 (3.4)	82.4 (3.9)**	76.8 (4.3)#
Cardiac output (L/min)	5.2 (0.8)	6.4 (0.6)*	5.5 (0.9)#
Stroke volume (ml/beat)	71.3 (4.6)	76.2 (5.5)*	74.8 (5.6)#
Systemic peripheral resistance (dyne. s/cm^5)	1355.1 (9.8)	1399 (19.4)**	1376.2 (15.2)#
Cardiac index (L/min/m^2)	3.1 (0.1)	3.6 (0.2)*	3.3 (0.1)#
Stroke volume index (ml/beat/m^2)	43.8 (3.2)	45.46 (4.3)*	44.9 (3.2)#
Systemic vascular resistance index (dyne. s/cm^5/m^2)	767.5 (14.5)	793.5 (15.1)**	775.2 (10.5)#

*Comparison between before CPT and immediately after CPT *P<0.05, **P<0.01. #Comparison between before CPT and 5 min after CPT #P<0.05. Data presented as mean (SD). Analysis of data was done by One-way ANOVA and Tukey *post-hoc* tests. CPT: Cold pressor test, SD: Standard deviation

Table 3: Comparison of cardiovascular parameters before and after CPT in obese while subjects performing ANB exercise during and after CPT

Cardiovascular parameters	Before CPT	Immediately after CPT (with ANB)	5 min after CPT (with ANB)
Systolic blood pressure (mm Hg)	116.8 (5.4)	138.2 (5.5)*	117.4 (6.7)^
Diastolic blood pressure (mm Hg)	76.3 (5.4)	88.4 (6.2)**	77.2 (5.7)^
Heart rate (per minute)	73.2 (4.6)	80.6 (5.5)**	73.4 (5.4)^
Cardiac output (L/min)	5.1 (0.9)	6.3 (0.8)*	5.2 (0.7)^
Stroke volume (ml/beat)	70.8 (4.4)	76.2 (4.6)*	71.1 (6.4)^
Systemic peripheral resistance (dyne. s/cm^5)	1355.1 (9.8)	1390 (19.4)**	1360.2 (15.2)^
Cardiac index (L/min/m^2)	3.1 (0.3)	3.5 (0.4)*	3.2 (0.5)^
Stroke volume index (ml/beat/m^2)	43.9 (3.2)	45.5 (4.6)*	44.1 (5.4)^
Systemic vascular resistance index (dyne. s/cm^5/m^2)	766.2 (15.6)	791.3 (16.4)**	770.2 (11.5)^

*Comparison between before CPT and immediately after CPT with ANB *P<0.05, **P<0.01. ^Comparison between before CPT and 5 min after CPT with ANB ^P>0.05 (non-significant). Data presented as mean (SD). Analysis of data was done by one-way ANOVA and Tukey *post-hoc* tests. ANB: Alternate nostril breathing, CPT: Cold pressor test, SD: Standard deviation of stress, ANB reduces the increased sympathetic activity produced by cold stress and increases the parasympathetic activity. These findings are in line with the previous studies demonstrating higher parasympathetic activity and improved cardiovascular functions after several weeks training of ANB.[13,14] In contrast, Subramanian et al. demonstrated an increase in low frequency (marker of sympathetic activity) and decrease in high frequency (marker of parasympathetic activity) in heart rate variability (HRV) and concluded with shift of sympathovagal balance toward sympathetic side as an immediate effect of ANB on HRV in non-practitioner of yogic breathing.[17] Pal et al. compared the effects of left nostril breathing (LNB) and right nostril breathing (RNB) and concluded that 6-week short-term practice of LNB increases parasympathetic activity by increasing vagal tone while RNB increases sympathetic tone.[18] However, Jain et al. did not find any significant difference between LNB and RNB neither after acute exposure nor after training of 8 weeks and concluded enhancement of parasympathetic activity by both LNB and RNB in comparison to normal breathing.[19]

In the present study, ANB exercise was not able to affect the cardiovascular changes produced by cold stress. This indicates that ANB does not generate very strong stimulation of parasympathetic nervous system. Cold stress produces intense stimulation of sympathetic nervous system and leads to almost complete withdrawal of parasympathetic activity.[7] Parasympathetic stimulatory effect of ANB is masked by much stronger sympathetic stimulus of cold stress. However, ANB exercise helps in faster and complete recovery after removal of cold stress in obese by its weak parasympathetic stimulatory effect, and therefore, there was no significant difference in cardiovascular parameters after 5 min with ANB exercise in comparison to basal parameters in Step 2. This also indicates that ANB tends to normalize the altered sympathovagal balance in obese. ANB exercise might not help during acute stress, but it may lead to faster recovery after removal of stressor. Thus, practicing ANB daily and using it after being got stressed must be beneficial in coping up stress in better way in obese people.

Strength of the Study

Direct measurement of effects of acute stress and its modulation by ANB on cardiovascular parameters in obese subjects by impedance cardiovasograph is the key strength.

Limitations of the Study

The study is limited to healthy young male adults and not involving patients suffering from hypertension and other cardiac diseases because acute stress produced by CPT may worsen the condition of these patients. Females were not involved in the study because the changes in autonomic and hormonal status during various phases of menstrual cycle may affect the results.

CONCLUSION

ANB may improve the cardiovascular functions by faster recovery from stress-induced harmful effects on cardiovascular system in obese subjects. Therefore, it may be a useful tool for obese people in coping up the stress in better way leading to better life.

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